Attorney Docket No. 1322/158

UNITED STATES PATENT APPLICATION

METHODS AND SYSTEMS FOR AUTOMATED ANALYSIS OF SIGNALING LINK UTILIZATION

Inventors: Steven Michael Freedman, Raleigh, North Carolina

Assignee: Tekelec

Entity: Large Entity

JENKINS, WILSON & TAYLOR, P.A.
Suite 1400, University Tower
3100 Tower Boulevard
Durham, North Carolina 27707
Telephone: 919-493-8000
Facsimile: 919-419-0383

"Express Mail" mailing number EV 412 492 864 US
Date of Deposit November 6, 2003
I hereby certify that this correspondence is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 C.F.R. 1.10 on the date indicated above and is addressed to Mail Stop Patent Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.
Gayle W. Chaney
Gayle W. Chaney

Description

METHODS AND SYSTEMS FOR AUTOMATED ANALYSIS OF SIGNALING LINK UTILIZATION

Technical Field

The present invention relates to methods and systems for analyzing signaling link utilization. More particularly, the present invention relates to methods and systems for automated analysis of signaling link utilization.

Background Art

In telecommunications networks, signaling links carry signaling messages between signaling nodes. In modern telecommunications networks, the signaling links are separate from the media trunks used to carry media communications between end users. The signaling messages that traverse the signaling links include messages used to set up and tear down calls, database queries and responses, and network management messages.

Due to the vital function performed by signaling links in telecommunications networks, it is desirable to ensure that signaling links are available at all times to send and receive signaling message traffic. For example, a DS0 link is capable of carrying data at 56 kilobits per second. 56 kilobits per second translates into 7,000 bytes per second. In order to ensure that a

signaling link does not become congested, networks are typically engineered such that signaling links are 40% loaded. Using the DS0 link as an example, this means that a DS0 link is typically engineered to carry 40% of 7000 or 2800 bytes per second. Assuming an average message size of 40 bytes, a DS0 signaling link engineered for 40% capacity can carry 70 messages per second.

While engineering signaling links for 40% or other capacity is a good practice, sudden bursts of signaling messages or network management messages may cause a link to become congested and temporarily unavailable to carry signaling message traffic. Since such a situation is undesirable, service providers use network monitoring systems to analyze signaling link utilization and determine causes of over-utilization of signaling links.

One problem with conventional network monitoring systems is that analyzing signaling link utilization requires a user to identify a signaling link that has become congested and to manually search through signaling message data to determine the cause of the signaling link congestion. For example, link utilization applications typically display link utilization information for a plurality of different signaling links on a single display screen. In order to diagnose a signaling link utilization problem, a user must manually identify the signaling link that caused the problem and the time period over which the problem occurred from the link utilization application. The user must then terminate the link utilization application and execute a protocol analysis application. Using the protocol analysis application, the user must input the parameters associated with the signaling link of interest and the time period and extract the corresponding

messages from a signaling message database. Such a manual link utilization diagnosis process is labor-intensive and subject to user errors.

Accordingly, there exists a need for improved methods and systems for automated analysis of signaling link utilization.

Disclosure of Invention

The present invention includes methods and systems for automated analysis of signaling link utilization. According to one exemplary method, signaling messages are copied from a plurality of different signaling links and stored in a database. Link utilization data is derived from the data in the database and displayed to a user in graphical format via a computer display device. The user analyzes the graphical data and selects, using a user input device, a portion of the link utilization data that the user desires to analyze. Based on the portion of the link utilization data selected by the user, signaling message data corresponding to the selected portion is automatically extracted from the message database. In one implementation, the user can launch a protocol analysis application from a link utilization screen simply by clicking on the link utilization data of interest using a mouse. The signaling message data is then displayed to the user. The user can use the signaling message data to determine the cause of the signaling link utilization problem. Thus, signaling link utilization and protocol analysis functions are combined. Because the signaling message data corresponding to the point selected by the user in the link utilization data is automatically extracted from the database and displayed to the

user, the time required for analyzing link utilization problems is greatly reduced over conventional manual methods.

Accordingly, it is an object of the invention to provide methods and systems for automated analysis of signaling link utilization.

It is another object of the invention to provide a convenient graphical user interface for a user to automatically analyze signaling link utilization data.

It is yet another object of the invention to combine signaling link utilization functions with protocol analysis functions in a network monitoring system.

Brief Description of the Drawings

Preferred embodiments of the invention will now be described with reference to the accompanying drawings of which:

Figure 1 is a block diagram of a network monitoring system including an automated signaling link utilization analyzer according to an embodiment of the present invention;

Figure 2 is a flow chart illustrating exemplary steps for performing automated signaling link utilization analysis according to an embodiment of the present invention;

Figure 3 is a computer screen shot of signaling link utilization data that may be displayed to a user by an automated signaling link utilization analyzer according to an embodiment of the present invention;

Figure 4 is a computer screen shot illustrating exemplary message data that may be displayed to a user based on selected signaling link utilization data selected by the user according to an embodiment of the present invention; and

Figure 5 is a block diagram illustrating an alternate implementation of a network monitoring system including an automated signaling link utilization analyzer according to an embodiment of the present invention.

Detailed Description of the Invention

Figure 1 is a block diagram illustrating a network monitoring system including an automated signaling link utilization analyzer according to an embodiment of the present invention. Referring to Figure 1, the network monitoring system may include components internal to a signaling message routing node, such as STP **100**, and external components **102**, **104**, and **106** that process and analyze signaling messages copied from STP **100**.

In the illustrated example, the internal components include message copy functions **108** located on link interface modules **110** and a network monitoring transport card **112**. Message copy functions **108** copy signaling messages sent and received over external signaling links. Network monitoring transport card **112** transports messages copied by message copy functions **108** to external network monitoring processors **102**.

In addition to network monitoring components, STP **100** includes message routing functions **114** resident on link interface modules **110** and database service functions **116** resident on a database services module **118**. Message

routing functions **114** route or transfer signaling messages between signaling links. For example, message routing functions **114** may implement MTP level 3 routing for SS7 signaling messages or IP routing for IP signaling messages. Database service functions **116** may perform database-related services for received signaling messages, such as global title translation and number portability lookups.

From a hardware perspective, each of the modules in STP **100** may include a printed circuit board including an application processor and a communications processor mounted thereon. The applications processor may perform signaling message processing functions, such as routing and message copying. The communications processor may control communications between processing modules over a pair of counter rotating, dual ring buses **120**.

The external components of the network monitoring system illustrated in Figure 1 include network monitoring processors **102**, network monitoring server **104**, and user terminal **106**. Network monitoring processors **102** receive signaling messages copied by message copy functions **108** and store the signaling messages in a signaling message database **122**. Network monitoring processors **102** may be connected to network monitoring server **104** by any suitable type of network, such as a service provider's internal IP network **124**. Similarly, user interface **106** may be connected to network monitoring server **104** by a public or private IP network **126**. In one example, network monitoring server **104** may include a web server, user terminal **106** may include a web client, and network **126** may be the public Internet.

The signaling messages for multiple signaling links may be intermixed in database **122**, making analysis using manual methods difficult. In order to avoid this difficulty, network monitoring server **104** includes a link utilization application **128**, an automated link utilization analyzer **130**, and a user interface **132**. Link utilization application **128** analyzes signaling link utilization based on messages stored in database **122** and displays the signaling link utilization to a user in a convenient format, such as a graphical format. The graphical format may include link utilization data for many different signaling links. The user may select a portion of the graph that corresponds to a spike or instance of comparatively high link utilization. Automated link utilization analyzer **130** automatically extracts signaling message data from signaling message database **122** corresponding to the selected link utilization data and displays the signaling message data for the user. In one implementation, automated link utilization analyzer **130** may include a protocol analysis application that can be launched from a link utilization screen displayed by link utilization application **128** in response to the selection by the user. User interface **132** displays the signaling message data to the user via a convenient interface, such as web browser. Because the user can automatically launch a protocol analysis application from a link utilization screen and view the signaling messages that cause link utilization problems, the time required to diagnose utilization problems is decreased over that of conventional manual methods.

Figure 2 is a flow chart illustrating exemplary steps for automated signaling link utilization analysis according to an embodiment of the present

invention. Referring to Figure 2, in step **200**, signaling messages are copied from signaling links and stored in a database. In Figure 1, this function is performed by message copy functions **108**. In one exemplary implementation, message copy functions **108** broadcast network monitoring service request via UDP to network monitoring processors **102**. Each network monitoring processor **102** may be preconfigured to service a particular message copy function **108** or group of message copy functions **108**. Accordingly, the network monitoring processor provisioned to service a particular message copy function **108** responds to the broadcast service request with a service acceptance. A TCP/IP connection is then established between the message copy function **108** and one of the network monitoring processors **102** via network monitoring transport card **112**. Copied messages are then sent over the TCP/IP connection and stored in signaling message database **112**.

In step **202**, link utilization data is generated for different signaling links. This function may be performed by link utilization application **128** on network monitoring server **104** based on messages stored in database **122**. For example, link utilization application **128** may count the number of signaling messages received per unit time for each signaling link being monitored. The signaling link may be identified by one or more parameters in the signaling message, such as the originating point code (OPC), destination point code (DPC) and circuit identifier code (CIC), or by a link identifier that a message copy function **108** associates with the signaling message.

In one exemplary implementation, message copy functions **108** may encapsulate each copied signaling message in a network monitoring packet that indicates the type and origin of a particular message. One type of packet that may be used is a link data packet. A link data packet includes a header that identifies the card and port on which a particular message was received. The card and port identifiers in the link data message may be used by link utilization analyzer **128** to count messages that traverse a particular signaling link. Exemplary network monitoring packet formats suitable for use with embodiments of the present invention are described in commonly assigned, co-pending U.S. patent application number 10/154,309, filed May 23, 2002, the disclosure of which is incorporated herein by reference in its entirety.

In step **204**, signaling link utilization data is displayed to a user. The signaling link utilization data may be displayed to the user in any convenient format, such as graphical format or tabular format. Figure 3 illustrates an example of signaling link utilization data that is displayed to a user in graphical format. In Figure 3, the ordinate axis represents time and the abscissa axis represents link occupancy per unit time. Each color represented in the graph represents utilization of a different signaling link. As illustrated in Figure 3, signaling data for a plurality of different signaling links may be displayed to the user. However, using conventional network monitoring systems, the user will be required to manually extract signaling message data for link occupancy data of interest to the user. Using a conventional network monitoring system, this step would be performed by the user identifying data of interest from the link utilization

graph, manually identifying the signaling link, manually launching a protocol analysis application, and manually inputting parameters to extract data for the link of interest. Such a process is time consuming and error prone.

The present invention automates signaling link utilization analysis by allowing the user to automatically launch a protocol analysis application from the link utilization screen. In one implementation, the user is allowed to select link occupancy data from the display of link occupancy data and automatically receive the corresponding signaling message data. Accordingly, in step **204**, input from the user is received regarding a portion of the link utilization data desired to be analyzed. In the example illustrated in Figure 3, the user may select spike **300** using a user input device, such as a keyboard or mouse, because spike **300** includes the highest point of link occupancy data in the graph. In step **208**, signaling message data corresponding to the selected link occupancy or utilization data is extracted from message database **122**. In order to extract the correct information, automated link utilization analyzer **130** may identify the data that the user selected. This step may be performed by selecting the point on the graph closest to the point on which the user clicked. Once the point is identified, the corresponding signaling link and time period are identified. The signaling link and time period may then be used as a filter for filtering signaling messages in database **122**.

Returning to Figure 2, in step **210**, the signaling messages data is displayed to the user. Figure 4 illustrates an example of signaling message data that may be displayed to the user. In Figure 4, the signaling message data

includes the date on which a signaling message was sent, the time, the sending node, the link ID, the type of signaling message, the count, the length, and other information regarding the signaling message. Using this information, the user can diagnose the cause of signaling link utilization problems. For example, if all signaling messages on an over-utilized link are from a short message service center, the spike in signaling link utilization may be caused by spam SMS messages. In another example, if all of the signaling messages are directed to an 800 number database for determining the directory number corresponding to an 800 number for a radio station, a radio station call-in contest may be determined to be the cause of the signaling link over-utilization. By displaying the signaling messages corresponding to the signaling link utilization data in a convenient format, the present invention greatly reduces the time required to diagnose signaling link utilization problems over the time required using conventional network monitoring systems.

The present invention is not limited to displaying the signaling message data illustrated in Figure 4. Any suitable data that may be extracted from or derived from signaling messages on a particular signaling link is intended to be within the scope of the invention. For example, automated signaling link utilization analyzer **126** may display the TCAP, MAP, or other application level message type so that the application that caused the link utilization problem can be identified. In addition, for IP telephony signaling messages, automated signaling link utilization analyzer **130** may display the signaling message type for similar diagnostic purposes.

Although in the embodiment illustrated in Figure 1 the automated signaling link utilization analyzer **130** was used with a network monitoring system that was partially implemented using components within a network routing node, the present invention is not limited to such an embodiment. Figure 5 illustrates an alternate implementation of a network monitoring system with which automated signaling link utilization analysis of the present invention may be used. Referring to Figure 5, a network monitoring system includes network monitoring shelves **500** and signaling link probes **502** for copying signaling messages on access links between service switching points **504** and signaling transfer points **506**. Network monitoring shelves may include link interface modules for copying the signaling messages and link interface cards for processing the signaling messages. Examples of network monitoring shelves **500** include the i2000 and i3000 shelves available from Tekelec of Calabasas, California.

The network monitoring system also includes site collectors **508** for received signaling messages copied from the signaling links and storing the signaling messages copies in signaling message database **122**. Site collectors **508** may be implemented using a general purpose computing platform, such as a netrawork station available from SUN Microsystems.

Network monitoring server **104** may include the same components as the corresponding network monitoring server illustrated in Figure 1. These components include link utilization application **128**, automated signaling link utilization analyzer **130**, and user interface **132**. A description of these

components is provided above with regard to Figure 1 and is not repeated herein.

In operation, network monitoring shelves **500** copy signaling messages received on the access signaling links. Site collectors **508** receive the signaling message copies and store the signaling messages in databases **122**. Link utilization application **124** accesses the messages in databases **122** and displays link utilization data, similar to that illustrated in Figure 3. The end user, using a user input device, selects some of the link utilization data for which further analysis is desired. Automated signaling link utilization analyzer **130** determines the link utilization data selected by the user, formulates parameters for filtering messages stored in database **122**, filters the appropriate messages and displays the messages to the user. The user can then diagnose the cause of signaling link utilization problems.

Thus, as described herein, the present invention includes methods and systems for automated signaling link utilization analysis. Rather than requiring the user to separately analyze link utilization and signaling message data, the present invention automates this process by linking signaling link utilization data with signaling message data in an automated manner. Because this data can be linked and displayed to the user in a convenient format, the time required for diagnosing signaling link utilization problems is reduced.

It will be understood that various details of the invention may be changed without departing from the scope of the invention. Furthermore, the foregoing

description is for the purpose of illustration only, and not for the purpose of limitation--the invention being defined by the claims.